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DEFENSE CENTER

June 4, 2020

Chair E. Joaquin Esquivel and Board Members
State Water Resources Control Board
1001 I Street
Sacramento, CA 95814
Joaquin.Esquivel@waterboards.ca.gov

Submitted electronically to Joaquin.Esquivel@waterboards.ca.gov, Laurel.Firestone@waterboards.ca.gov, Tam.Doduc@waterboards.ca.gov, Dorene.Dadamo@waterboards.ca.gov, Sean.Maguire@waterboards.ca.gov

Re: Expert Report on Application for Aquifer Exemption in the Sisquoc and Monterey Formations of the Cat Canyon Oil Field, Santa Barbara County, California

Dear Chair Esquivel and Board Members,

The attached expert report is submitted by the Environmental Defense Center ("EDC") on behalf of the Sierra Club, by and through the Los Padres Chapter ("Sierra Club"), the Santa Barbara County Action Network ("SBCAN"), and EDC regarding the Application for Aquifer Exemption in the Sisquoc and Monterey Formations of the Cat Canyon Oil Field in Santa Barbara County, California ("Application"). The report submitted by Dr. Barry Keller, PhD, and Dr. Jay C. Means, PhD, provides a technical analysis demonstrating that the Application has not satisfied the criteria under Public Resources Code Section 3131(a).

Pursuant to this section, a proposal by the state to exempt an aquifer to inject oil and gas fluids requires the California Geologic Energy Management Division ("CalGEM") and the State Water Resources Control Board ("SWRCB") to ensure, in relevant part, that "[t]he injection of fluids will not affect the quality of water that is, or may reasonably be, used for any beneficial use," and "[t]he injected fluid will remain in the aquifer or portion of the aquifer that would be exempted." Pub. Res. Code § 3131(a)(2)-(3). For the reasons set forth in the attached report, the Application fails to consider the potential for injected fluids to migrate vertically upward within fault zones or through existing wells to impact the quality of freshwater resources, particularly

906 Garden St. Santa Barbara, CA 93101
PHONE (805) 963-1622 FAX (805) 962-3152
www.EnvironmentalDefenseCenter.org

given the complex mixture of toxic materials in produced water. Such migration could also be greatly exacerbated by a seismic activity.

Dr. Keller is a California professional geologist (#446) and California certified hydrogeologist (#370). Over the course of his career, Dr. Means, DABT (2007-2012) and Fellow of the Academy of Toxicological Sciences, has been involved in developing trace analytical methodology and its application to the analysis of environmental media, including water, sediments, biological tissues, and air. He has forty years of experience in investigating impacts of oil and gas production on ecological and human health.

The Sierra Club is dedicated to exploring, enjoying, and protecting the wild places of the earth; to practicing and promoting the responsible use of the earth's ecosystems and resources; to educating and encouraging humanity to protect and restore the quality of the natural and human environment; and to using all lawful means to carry out these objectives. SBCAN is a countywide grassroots organization that works to promote social and economic justice, to preserve our environmental and agricultural resources, and to create sustainable communities. EDC is a non-profit, public interest law firm that protects and enhances the environment in Santa Barbara, Ventura, and San Luis Obispo Counties through education, advocacy, and legal action. Our clients have members who live, visit, work, and recreate in the Cat Canyon area and would be affected by the approval of the Application.

Based on the attached expert report and the other materials that we have submitted to date, we reiterate our request that SWRCB direct staff to not concur on the Application or at least pause the review process until the U.S. Geological Survey completes its groundwater study in the Cat Canyon Oil Field. Thank you for your consideration of this matter. If you have any questions, please do not hesitate to reach out to Tara Messing, EDC Staff Attorney, at 805-963-1622 x104 or TMessing@EnvironmentalDefenseCenter.org.

Sincerely,

Linda Krop
Chief Counsel

Tara C. Messing
Staff Attorney

Dr. Jay C. Means, Ph.D., DABT [07-12], ATS
Professor of Toxicology and
Environmental Chemistry [retired]

Barry Keller PhD
CA Professional Geologist #4460
CA Certified Hydrogeologist #370

Chair E. Joaquin Esquivel and Board Members
State Water Resources Control Board
P.O. Box 100
Sacramento, CA 95812-0100

Submitted electronically to Joaquin.Esquivel@waterboards.ca.gov, Laurel.Firestone@waterboards.ca.gov, Tam.Doduc@waterboards.ca.gov, Dorene.Dadamo@waterboards.ca.gov, Sean.Maguire@waterboards.ca.gov

RE: Technical Comments on the Application for the Expansion of the Aquifer Exemption in the Sisquoc and Monterey Formations in the Cat Canyon Oil Field, Santa Barbara County, California

Dear Chair Esquivel and Board members,

This report details a review of the technical, scientific, and practical issues related to the Application for Aquifer Exemption in the Sisquoc and Monterey Formations of the Cat Canyon Oil Field in Santa Barbara County, California ("Application"), as depicted in Figure 1 below.

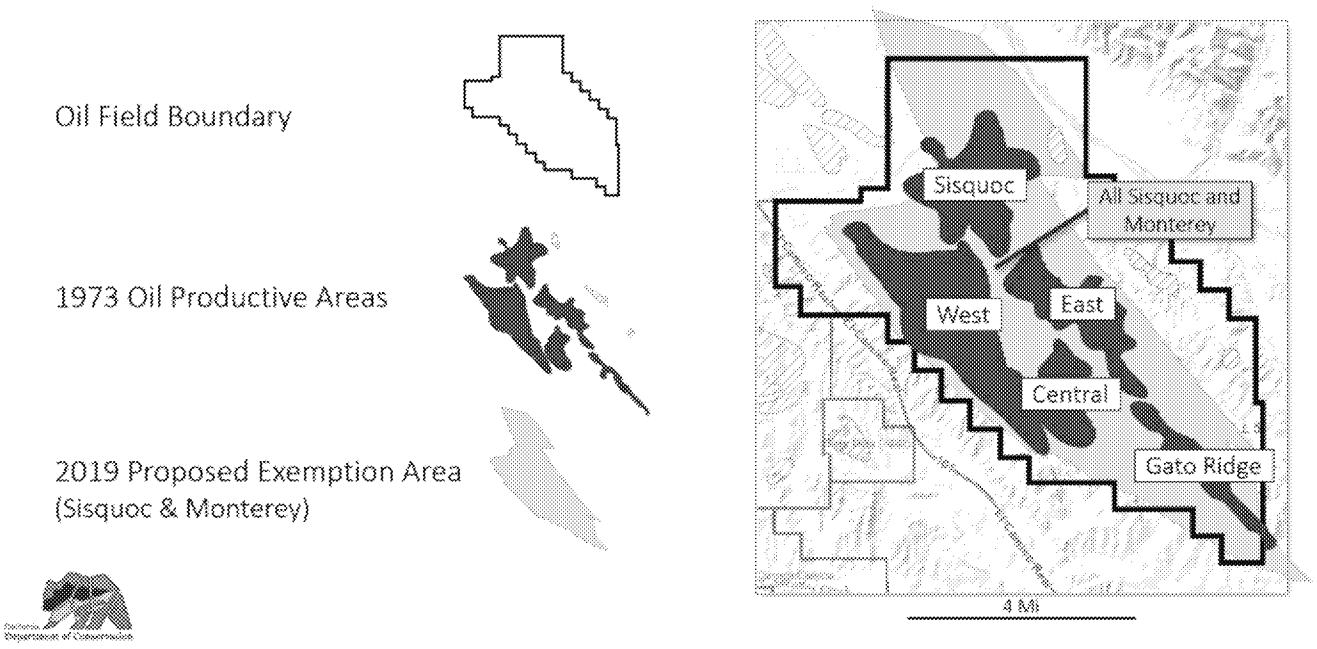


Figure 1. Slide 9 from the California Department of Conservation's PowerPoint presentation dated June 5, 2019 entitled, "Aquifer Exemption; Cat Canyon Oil Field: Sisquoc and Monterey Formations."

A review of the Application and geologic literature for the Cat Canyon area and the larger central California region indicates that the geologic and tectonic configuration in the vicinity of the Proposed Expanded Aquifer Exemption is likely susceptible to upward migration of fluids from exempted aquifers to shallower levels with drinking water aquifers. Such migration could also be greatly exacerbated by a significant earthquake.

Figure 2 below shows the location of the Proposed Exemption Expansion (Cat Canyon Oil Field) on a schematic map of faults in southern and central California. The location is in a zone of north-northwest trending faults to the west of the San Andreas Fault, which is considered to be the main boundary between the North America and Pacific tectonic plates.

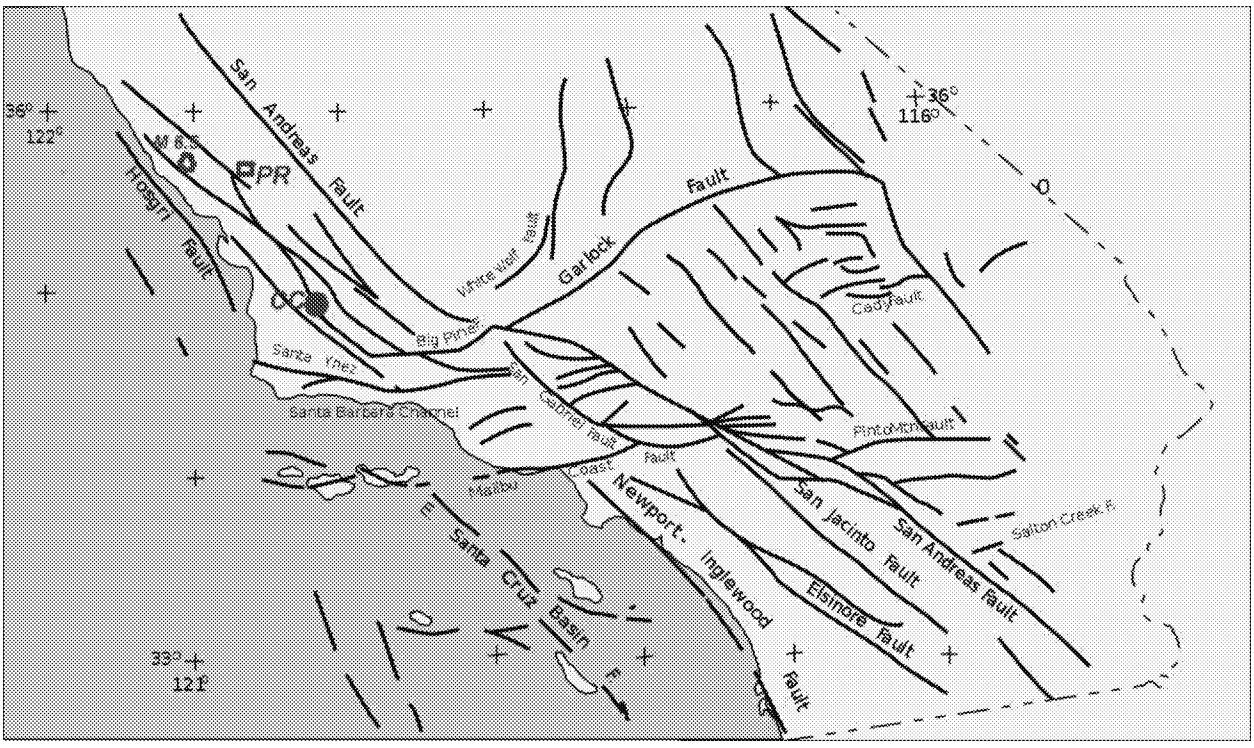


Figure 2. Schematic fault map of central and Southern California, showing the locations of Cat Canyon Oil Field (CC), the epicenter of the 2003 San Simeon earthquake (M 6.5) with a 6.5 magnitude, and the city of Paso Robles (PR). Information from Southern California Earthquake Center (SCEC). Additions in red by Dr. Barry Keller.

This report focuses on:

- The potential for injected fluids to migrate vertically upward within fault zones or existing oil wells in Cat Canyon Oil Field, particularly given the solubility of the contaminants found in produced water;
- The potential for such migration in Cat Canyon Oil Field to be exacerbated by earthquakes;
- The toxicity of the chemicals present in injected fluids that could migrate vertically to impact the quality of freshwater; and
- Deficiencies and omissions in the Application's discussion about the numerous chemicals present in oil-field fluids and thermogenic gases that can migrate vertically to contaminate freshwater aquifers, including issues of completeness, quality control, and reporting.

Regarding the Application, it must be noted that such an exemption has been in effect for some decades in this oil field, and the present project is to expand the area of the exemption to allow for the additional injection of steam and wastewater, which represents substantial increases in impacts upon Cat Canyon. In addition to these activities, the region is also used extensively for agricultural production of a variety of crops as well as utilization as grazing lands for cattle and sheep. The regions to the north and west of Cat Canyon have small to moderate sized towns and cities including Los Alamos, Orcutt, Sisquoc, and Santa Maria with populations ranging from a few

hundred to 100,000 inhabitants. Aquifers in the Cat Canyon supply local needs for irrigation water and drinking water supplies to communities. Cyclic periods of drought as well as changes in land use and increasing regional populations have placed additional stress on water resources in the area.

During the period of the existing exemption, evidence demonstrates that there have likely been impacts to drinking water aquifers from oil and gas activities in the Field, although not reported in the Application. Furthermore, the U.S. Geological Survey ("USGS") is currently sampling groundwater quality in Cat Canyon to determine possible groundwater contamination from oil and gas sources as well as what pathways or processes are responsible for the observed transport. In addition to this data and analysis by USGS, this report discusses the pathways for contamination of freshwater sources from oil and gas activities if this Application is approved.

I. Geology in the Cat Canyon Oil Field

Cat Canyon is located in the central coast of California and like much of the region has been the site of extensive geologic changes over millennia right up to the present time. The geologic setting of the Cat Canyon Oil Field is a stratigraphic "layer cake" with approximately horizontal sedimentary rocks deformed and cut by northwest-trending folds and faults. See the series of cross sections in Figure 4-1 of the Application, and see that document for a more complete description of the geologic units. Beneath the "layer cake" of sedimentary deposits are metamorphic, igneous, and sedimentary rocks of the Franciscan Assemblage, a tectonic "mélange" (mixed up assortment) that is approximately 100 million years old (Cretaceous age). In some locations, sedimentary rocks of similar age are present, called Knoxville formation. The "layer cake" is a sequence of sedimentary "formations" (identifiable and distinguishable packets of rock) of Tertiary age. At the base of the Tertiary sedimentary sequence is the Point Sal formation, which does not produce oil. Overlying this, progressively shallower and younger units are the Monterey formation, Sisquoc formation, Foxen formation, Careaga formation, and Paso Robles formation, with other younger, shallower units in some locations. Oil is produced from the Monterey and Sisquoc formations, while the Careaga, Paso Robles, and shallower units are utilized as drinking water aquifers. The texture [range and distribution of particle sizes], consolidation, permeability and interstitial spaces or porosity of the sediments are highly variable.

II. Presence of Chemical Constituents in Produced Water

Produced water contains a very complex mixture of chemicals including hundreds of different aliphatic and aromatic hydrocarbons, major elements [Na, Ca, Mg, K, Fe, etc.] and their salts [Cl, HCO_3, SO_4, Br, etc.], but also a large number of trace elements that are highly toxic, even in small amounts [Ba, Cd, Cr, Zn, As, Se, Hg, Sn, Li, Sr]. (Rabalais, McKee, Reed and Means, 1991) These trace metal contaminants can cause a broad spectrum of toxicological effects in humans and wildlife including kidney and liver damage, neurotoxicity, and cancer. (*Id.*) In addition to these substances, produced water also contains naturally occurring radionuclide isotopes of a few elements [PB_{210},

Ra_{226}, Ra_{228}, H_3, Sr_{90}, Rn_{222}]. (*Id.*) These radionuclide decay emitting alpha, beta or gamma radiation that is hazardous to humans causing cell death, DNA damage, and cancers. (*Id.*)

In consideration of the Application, the California Geologic Energy Management Division ("CalGEM") and the State Water Resources Control Board ("SWRCB"), with the goal of protecting present and future drinking water supplies for human consumption and agricultural uses, failed to require the assessment of the most toxic components of produced water in the form of trace elements, aromatic hydrocarbons and radionuclides. Data demonstrate the diversity of toxic substances present in produced waters, including toxic trace metals, parent and alkylated and heterocyclic aromatic hydrocarbons, and radioisotopes. (Means, 1989). Note that alkylated aromatic hydrocarbons dominate the aromatic fraction. These chemicals bioconcentrate in organisms either through direct exposure or through food webs. They are carcinogens, potential mutagens and immune-modulators in humans and wildlife including fish species.

Interestingly, in response to a question from the SWRCB on total dissolved solids in a steam injection well [Ardantz #506 well], data were provided to the State showing that many of the constituents just discussed are present in produced waters and thus represent a contamination risk for aquifers in the Application. (Letter from Pat Abel to Jonathan Bishop, dated August 3, 2018, page 4. [see also Rabalais, McKee, Reed and Means, 1991].)

III. The Application Fails to Analyze the Potential for Vertically Upward Migration via Fault Zones and Thereby Cannot Demonstrate Isolation from Drinking Water Resources

Various faults cut some or all of these formations. As shown in the Application's Figure 4.1 cross sections, some of the faults extend vertically thought the entire "layer cake."[1] The Application claims that many of the faults act to laterally seal off blocks within the sedimentary sequence so that the petroleum reserves are trapped within the blocks, and pressure from injected fluids would not migrate to adjacent blocks.

However, the Application does not address the question of whether the fault zones themselves may function as vertical conduits for fluid motion, which could allow injected fluids to migrate upward into the potable water aquifer units. (Worts, 1951) Injected fluids which would include a complex mixture of drilling fluids, acidizing fluids and separated produced water carrying a wide variety of potentially toxic chemicals, trace metals and residual petroleum hydrocarbons would have hydraulic head equal to or greater than the land surface elevation, so if a conduit is available, the fluid would tend to travel upward. Volatile substances contained in these complex mixtures [methane as

[1] It should be noted that some faults shown in the Application as reaching the surface are not shown to do so on a standard geologic reference map (Dibblee, 1994) so the interpretation of the Application may be considered tentative.

well as toxic aromatic volatiles such as benzene and toluene] could also migrate upward in the gas phase as well. (Rabalais, McKee, Reed and Means, 1991)

Additionally, it is a common occurrence for springs to exist along geologic faults. In such cases, groundwater is blocked from lateral migration across a fault, but flows up along the fault to the surface. Thus a fault can act as a blockage to lateral migration of fluids but a conduit for vertical migration. Such a situation on the vertical faults that cut the sedimentary sequence in Cat Canyon Oil Field could provide conduits for pressurized injected fluids to migrate vertically from the Monterey and Sisquoc formations up into the Careaga and Paso Robles formations. It is logical therefore to be concerned that the complex mixtures of chemicals used in the cyclic steam injection process [many of which are water soluble], the acidizing streams [water soluble], along with toxic trace metals solubilized by the acids will move with potential groundwater migrations toward the surface. The reinjection of hypersaline produced water in large volumes [often hundreds of thousands of barrels over time] also carry a myriad of toxic aromatic and aliphatic hydrocarbons that will potentially migrate to shallower strata aquifers. Such migration would be enhanced over time by local and regional seismic activity depending upon the magnitude of the events.

There is observational evidence that such vertical migration of fluid on fault zones does occur in the project area. An early study of water resources in Santa Maria basin was done by Worts (1951). During geologic mapping to delineate the surface traces of faults, investigating the possible presence of a fault east of the Bradley Canyon fault, Worts (1951) noted "Additional inconclusive evidence was the presence of small tar seeps in the Careaga sand at Fuglar point, suggesting a fracture zone along which the tar might be rising." Thus, the observed upward vertical migration of hydrocarbon fluid was considered to be evidence of the presence of a fault, within a geologic unit (Careaga formation) known to be a drinking water aquifer.

Given current conditions in the Field, the water within the aquifer apparently does not appear to have sufficient hydraulic head to flow above ground to reach the surface in the Cat Canyon area, although it is unknown how this may be affected if this aquifer exemption is approved. Instead, as described by Worts (1951) all natural discharge of groundwater from the Santa Maria area (to which the Cat Canyon area provides recharge – Figure 5.1-15 of Application) is by flow westward under the Pacific Ocean coast, discharging in unconsolidated deposits exposed on the ocean floor, although during a wet period prior to the 1920s water was discharged from shallow sediments on land near Guadalupe. Thus, injected fluids, such as produced water, would be under pressure (i.e., greater hydraulic head than the groundwater) and could migrate upward from the project area.

IV. The Potential for Vertically Upward Migration via Active, Idle, and Abandoned Oil Wells is Not Considered in the Application

The Cat Canyon area has been an established area of oil and gas exploration for decades utilizing a variety of technologies from conventional drilling and pumping to

various enhanced recovery methods such as acidizing, water flooding, steam injection, CO_2 injection and chemical-enhanced production. Hundreds of wells have been drilled in the area over time with varying degrees of success in terms of economically viable oil and/or gas production.

The same contaminant mixtures and the potential risks of their upward migration into potable and agricultural aquifer resources through natural faults are multiplied many times over by damaged or abandoned oil wells. Pressurized fluids from injection zones in the Monterey and Sisquoc formations can vertically migrate into the Careaga and Paso Robles formations through existing oil wells (and perhaps even water wells at shallower depths). As noted in the Aera Draft Environmental Impact Report (Santa Barbara County, 2018), p 2-8, "The Cat Canyon Oil Field contains approximately 1,600 active and idle oil wells." Potential conduits include the well casings themselves and unsealed annular spaces remaining from well installation. Such vertically rising pressurized fluids might enter the Careaga or Paso Robles formation aquifers, if the fluids escape from inside the wells, so the potential for contamination exists. There is even greater potential if the casings of oil wells or shallower water wells have been damaged by earthquakes.

V. Fluid Migration Risk Associated with Earthquakes is Not Evaluated in the Application

It is well documented that earthquakes can be accompanied by changes in groundwater movement. As noted by Richter (1958), "When there is plenty of groundwater, a strong earthquake often produces fountains, spouts, "geysers" which play during the strong shaking and for some time afterward." That author also described oscillations of water levels in wells during and after earthquakes.

As discussed in the Application, the project area includes northwest trending mapped faults and fold structures. This is part of the regional plate tectonic pattern in the area west of the San Andres fault (see Figure 2). While the San Andreas fault is considered to be the main boundary between the Pacific Plate (the plate on the west side, moving to the northwest) and the North American Plate (the plate on the east), in reality the relative motion is distributed across a zone of deformation that includes smaller northwest trending faults that are approximately parallel to the plate boundary.[2] (Schulz & Wallace, 2016)

The potential for seismically induced fluid migration is due to the seismic risk present in the project area. This risk was considered in a CEQA document for a different project, the West Cat Canyon Revitalization Plan (ERG Final Environmental Impact Report, Santa Barbara County, 2019, Table 4.6-1) That standard engineering evaluation for seismic safety (i.e., based on mapped fault dimensions and proximity) included a number of faults that have been identified by surface geologic mapping, and included mention of the risk

[2] Note that it is often observed that actual earthquakes are often not clearly associated with previously mapped faults.

from blind thrust faults, which are slanted faults that are not identified at the surface, but may sometimes be identified on the basis of interpretation of drilling logs from oil or water wells. The faults listed in the CEQA document are regional mapped faults and the list does not include all of the "minor" mapped faults in the Exemption Project area (as shown in Application Figure 4.2-6), although two such minor faults, the Los Alamos fault and Foxen Canyon fault are included in that FEIR. The local listed faults are estimated to be able to generate earthquakes of magnitude 6.9 (Los Alamos fault) and 7.3 (Foxen Canyon fault). (ERG Final Environmental Impact Report Santa Barbara County, 2019) More distant faults (including the San Andreas fault) were estimated to be able to generate earthquakes as strong as magnitude 8. (*Id.*) Any of these hypothetical earthquakes, were they to occur, could cause strong ground shaking in the area of the Cat Canyon Oil Field, with potential damage to infrastructure, including wells.

Pertinent to the risk of seismically influenced fluid migration in Cat Canyon Oil Field is the actual case history of the 22 December 2003 "San Simeon earthquake", also called the "Paso Robles earthquake" because it caused infrastructure damage and two fatalities in the City of Paso Robles. This M_w 6.5 quake (as reported by USGS, 2004) occurred within the same northwest trending zone of faults and deformation that is observed in the Cat Canyon Oil Field (figure 2). The earthquake mechanism was interpreted to be a previously unmapped blind thrust, between mapped surface faults (the Oceanic and Nacimiento faults).

As shown below in Figure 3, the area of aftershocks (yellow dots), often interpreted to indicate the plane of motion in the main shock, do not delineate a simple linear trend. Also notable is that the city of Paso Robles, where groundwater discharge occurred, was actually at some distance (about 30 km) from the main shock epicenter. In the small inset map of Figure 3, the Cat Canyon area would be immediately southeast of the black area of "San Luis Obispo County", so it is located directly on the NW-SE tectonic trend of the San Simeon earthquake activity (see also Figure 2).

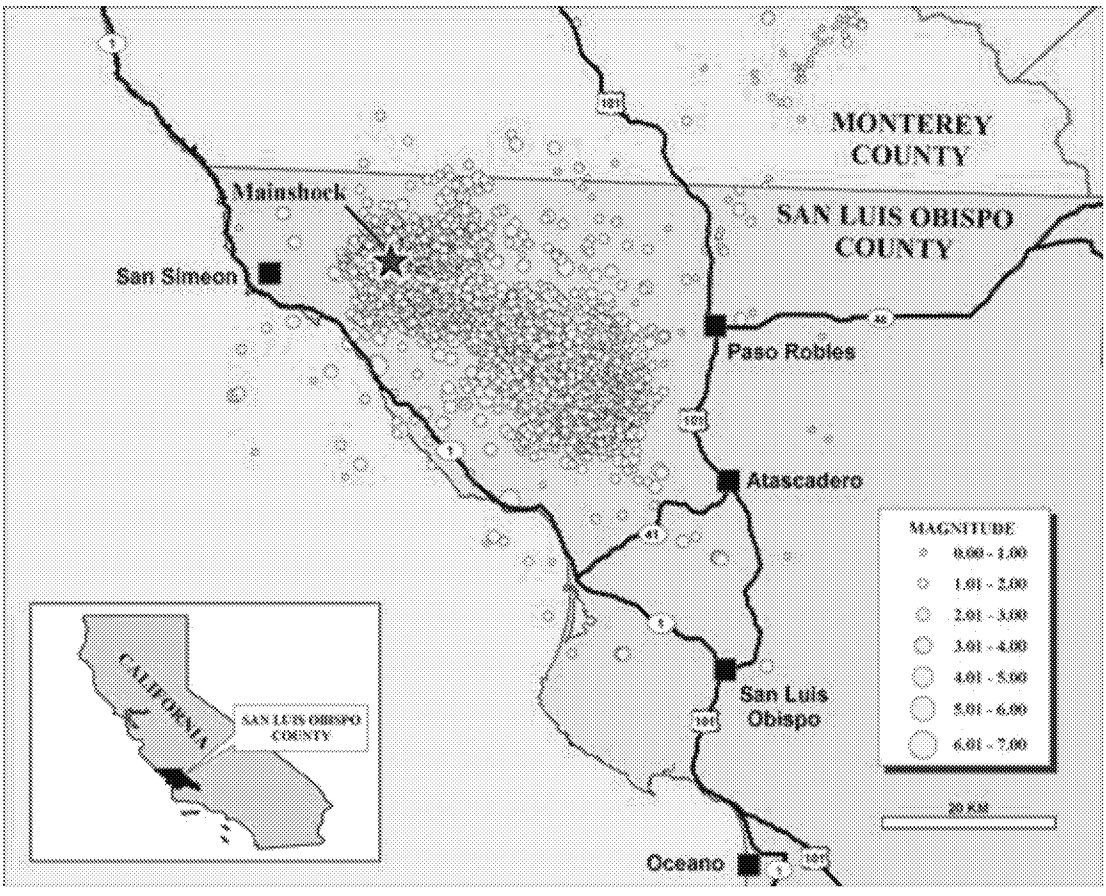


Figure 3. Location of the 2003 San Simeon earthquake (M = 6.5) and aftershocks.

Of more interest for the purposes of this report than the damage and injuries is the effect of the San Simeon Earthquake on flow of subsurface fluids. As reported by an earthquake engineering group (EERI, 2004):

> Hot Springs: Two hot sulfur springs in Paso Robles began to flow following the earthquake. One spring erupted beneath the surface parking lot at the Paso Robles City Hall. Hot water and sediment were spouting at a rate of approximately 82 liters per second (1300 gpm) at a temperature of 43°c (110°f), making the capping procedure difficult for the emergency construction crew. The spring is said to be at the site of an old bathhouse where an earlier spring was capped when the bathhouse closed down. A second hot spring also began to flow from the side of the U.S. Highway 101 embankment at the Paso Robles Road exit.

In consideration of its location in the same tectonic setting, the San Simeon earthquake may be considered as an example of potential seismic activity and impacts in or near the Cat Canyon Oil Field. This quake also included liquefaction and ground spreading effects that damaged infrastructure. Fluid migration [including the complex mixtures of toxic materials, including toxic trace metals, mutagenic, carcinogenic and suppressant aromatic hydrocarbons and radioluclides] as described above on faults and in wells within the Cat Canyon Oil Field could certainly be exacerbated by such an event, with

potential adverse impacts to the drinking water aquifers. (Rabalais, Mckee, Reed and Means, 1991, Daniels et al., 1990) (Daniels and Means, 1989)

VI. Issues of Completeness, Quality Control, and Reporting with Regards to the Application's Water Analyses is a Major Flaw, Especially Given the Likelihood of Non-Containment of the Injected Fluids

CalGEM and SWRCB are required to evaluate the quality of data submitted by the applicant in the Application. This quality assessment included the accuracy of information ranging from well identification codes, locations, depths and drilling logs and also quality assurance (QA) of physical analyses of temperatures, pressures, conductivity, pH and also chemical analyses of water. As part of these assessments, CalGEM and SWRCB appear they have done a rigorous assessment of most parameters, however, one important area appears to have been overlooked by reviewers. Quality assurance of chemical measurements are very dependent upon proper sample collection, preservation and timeliness of analyses. A review of the Application and supporting Appendices [Appendix 5-IV- Formation Water Analyses and Data and Appendix 3-1 DOGGR EPA MOU] indicate that numerous water samples collected, analyzed and reported in the Application failed to meet required quality assurance standards. The majority of the QA failures with samples were from ERG (now, TerraCore) and Vaquero. These failures included using improper sample containers (e.g. mason jars vs. precleaned plastic bottles) and failures to apply proper preservation methods (acidification, storage on ice, etc.) and thus compromised the accuracy of analysis data for certain parameters. (Application at Appendix 5-IV and Appendix 3-1) These failures in compliance with simple requirements suggest a potential for failure to comply with more serious regulations intended to protect human health, safety and environmental protection.

Further, the failure to establish existing levels of these same contaminants in the Sisquoc and Monterey aquifers which are to receive injected produced water, residual hydrocarbons (due to incomplete separation of oil), and additive chemicals used for separation and well maintenance creates a scenario where future contamination events could not be linked to the applicant's production/separation/injection operations. This "if you don't measure it, it's not there" approach to the regulation of oil field wastes often results in an inability to define the source of contamination and perform remediation. The vague aspects of the past history of oil and gas production pre-1977, with reported illegal drilling and injection operations mandate the State to establish a "background" for the Sisquoc and Monterey formations. An extension of this argument relates to possible non-containment of the injected materials leading to contamination of existing drinking water aquifers [above injection strata].

VII. The Analysis of the Total Petroleum Hydrocarbons is Improperly Omitted from the Application, Particularly with Regards to Re-Injection.

A review of the CalGEM and SWRCB levels of review of the documents seems to indicate that the CalGEM made only limited requests for additional information from the

applicants. These were limited to typos, some errors in calculations, inconsistent data between sections of the report and better definition of data from inside and outside the existing exempted areas. Exchanges between the SWRCB and the CalGEM were more substantive and resulted in improvements in existing water well inventories, use categorization, and maps. The applicant through CalGEM provided limited evidence of aquifer confinement and aquifer sediment permeability in the form of a dye tracer study and well pressure dissipation tests on a few existing wells. (See Application Appendix 6-III) These data based upon field scale withdrawal of fluids and a presumed mass balance were deemed insufficient by CalGEM staff, which required operational monitoring of injected fluids' lateral movement, and better definition of the upper confining layer thickness.

However, nowhere in the application itself, the CalGEM review, or SWRCB review is there mention of total petroleum hydrocarbons, measurement data on petroleum hydrocarbons in produced water, source water, water well water or surface water or the need for such data. This is a critical omission in the Application because: 1) the presence or absence of petroleum hydrocarbons is one of the criteria used to qualify the aquifer for exempt status, 2) petroleum hydrocarbons directly affect the water quality and potential treatability of the water for use, and 3) the lack of baseline petroleum hydrocarbons measurement data during the exemption process will prevent future proof of contamination of groundwater by operators if the exemption is granted.

The CalGEM website lists an updated document governing underground injection control. Section 174.7.2 on Liquid Analysis requires analysis of total petroleum hydrocarbons as an analyte. (Rabalais, McKee, Read and Means, 1991) An examination of the extensive data sets provided in the Application indicates that these analyses were not reported.

VIII. Several Chemicals Associated with Oil and Gas Activities that May Impact Water Quality are Either Not Disclosed or the Discussion is Based on a Misuse of the Information

The Application discloses aspects of the water quality of proposed injection fluids into the Sisquoc and Monterey formations. It is not only the produced water itself, which would constitute millions of barrels of produced water separated from the petroleum recovered, but it is also added mixtures of chemicals used in the separation process to maximize oil yield as well as added mixtures chemicals used to facilitate the injection process. **The Application, however, does not disclose any chemicals that might be utilized in the steam injection process or the production process itself which may include strong mineral acids such as HCL, H_2SO_4 and HF, hydrocarbon fractions [typically short chain aliphatic hydrocarbons and one- and two-ring aromatic hydrocarbons], detergents and other surfactants.** Table 6.4.1 lists only two specific chemicals [methanol and ethylene glycol] and two proprietary mixtures [amines and quaternary ammonium compounds].

The data are presented as amounts utilized in various stages of oil production and the function the chemicals provide. The amounts used are presented in two forms: "Maximum MSDS percent by weight" and "Maximum Composition-Allocated in Injection Stream, ppm." The Application states these data "*shows the summary of the maximum possible additives put into the oil field at various feed locations (into producing wells, separators, etc.) assuming the highest values in the ranges of product concentrations reported in MSDS. Three operators ERG, Vaquero Energy and B.E. Conway provided chemical use information. In combination these operators are responsible for 68% of the injection volume, (DOGGR, 2015).*" The data presented appear to be a misuse of information contained in MSDS sheets, which are intended to provide information of the potential health and occupational risks associated with a particular chemical from exposure through inhalation, ingestion and/or dermal contact. ("What is a Material Safety Data Sheet (MSDS)?" (Attachment A))

Attached hereto as Attachment A defines the content of MSDS sheets and lists the type of information contained in them. Note that workplace hazards and exposures are the primary focus of the MSDS sheets. While toxicity values of LD_{50} or LC_{50} are included, these represent acute toxicity (lethality) not the potential for long-term chronic exposures from contaminated water. Cautions about improper use and disposal of chemicals into environmental media that are known to represent a hazard or harm may be presented on these sheets but **these do not represent permissible amounts for any industrial use or process.** The same form of presentation of limits based in MSDS sheets utilized in Table 6.4.2 for describing "product concentration range and solubility of those common chemicals that could possibly be fed as part of a treatment product into oil streams, water streams" is equally erroneous.

The second form of the data in Table 6.4.1 claims to present the "maximum" ppm of chemicals injection streams. The chemical or physical basis for these representations, or any supporting chemical analyses are absent from the Application. The reference to CalGEM data could not be found. In fact, a search of the CalGEM website for the term "MSDS" yielded no results.

IX. The Chemicals Identified in the Application are Incomplete, Presenting an Unacceptable Risk of Contamination to Freshwater Aquifers

With specific regard to the chemicals listed in Table 6.4.1, all are known to be toxic to humans and to environmental species. (Hazardous Substances Database [HSDB]) The health risks of methanol are well established and include neurotoxicity, effects on the digestive system and effects upon pregnancy. (*Id.*) Ethylene glycol is a toxic chemical that can cause renal damage and secondary methanol toxicity due to metabolic breakdown. (*Id.*) The mixtures disclosed in Table 6.4.1 also have risks associated with them. Amines as class are organic chemicals that are derived from ammonia (NH_3), with one, two or three hydrogen atoms of ammonia molecule replaced by organic ligands, typically lipid-derived, such that: (1) primary amines, RNH_2, (2) secondary amines, R_1R_2NH, (3) tertiary amines, $R_1R_2R_3N$ and quaternary amines, $R_1R_2R_3R_4N^+X$, where X represents an anion such as chloride or sulfate are produced. (*Id.*) Amines are mildly

basic and may interact with acids to form organic salts. (*Id.*) Amines made from fatty acids are emulsifiers and oil-wetting agents for oilfield chemicals. (*Id.*) A related group of organic chemicals amides have the general formula $RCO\text{-}NH_2$ are partial oxidation products of amines. (*Id.*) Amides and so-called polyamides are emulsifiers and surfactants, many of which are made from lipids. (*Id.*)

The Application's discussion of the chemicals in Table 6.4.2 is largely limited to generic industry information that is only marginally accurate with regards to basic properties and presents no information on potential adverse health effects or environmental degradation. Each of these substances is a potential risk factor and information on those risks is readily available from public government databases. For example, the HSDB maintained by the National Library of Medicine in the National Instituted of Health is a useful source of toxicity information. The Database known as TOXNET is publicly available and is peer-reviewed. Included here are excerpts from the TOXNET [https//toxnet.nlm.nih.gov] for the toxicity of Methanol and Ethylene Glycol which are listed prominently in the Application.

TOXNET summarizes these risks as follows:
Permanent blindness, impaired speech and movement, and death have been reported in individuals that intentionally or accidently drank **methanol** and in workers exposed to very high air levels. Conjunctivitis, headache, stomach upset, blurred vision and partial blindness have also been reported in workers exposed to low-to-moderate air levels over time. Birth defects, including skeletal malformations and altered development of the urinary and cardiovascular systems, were observed in offspring of laboratory animals exposed to high air levels of **methanol** during pregnancy.

The health risk of ethylene glycol is also well established in the toxicological literature. TOXNET lists the potential effects as: Nasal and or throat irritation were reported in a small number of subjects inhaling **ethylene glycol**, while higher concentrations caused eye irritation. Available data from acute poisoning cases indicate that the kidney is the critical organ for the toxicity of **ethylene glycol**. Available data are inadequate to assess the potential adverse neurological or immunological effects associated with long term exposure to **ethylene glycol**, although neurobehavioral and neurological disorders have been reported in cases of acute **ethylene glycol** poisonings in humans.

Methanol is a known metabolic breakdown product of ethylene glycol. This point is acknowledged in the Application. Glycoxylate is another metabolite that is more toxic than the original chemical.

None of these risks are disclosed or discussed in the Application even though most of the discrete chemicals in Table 6.4.2 are found in the TOXNET database. Some of the proprietary products listed are not because they represent mixtures (e.g. quaternary ammonium salts), however, representative members of the class of chemical are generally available.

The discussion of the chemicals in Table 4.6.2 in the Application attempts to portray many of the substances as widely used in many products and therefore accepted as "safe". This is in error because the specific issue here is aquifer drinking water quality and safety.

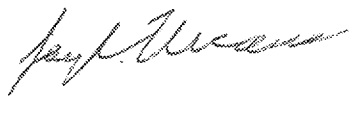
Furthermore, the discussion of these chemical components in the Application is limited to the functional or operational stages of the oil recovery process. There is no discussion of water quality either before (i.e. the produced water, sources water, etc.) or after the application of these chemicals (composite water quality) of the fluids being injected in the aquifers which are the subject of the Application.

Finally, Section 6.4.1.4.1 of the Application on injection water quality makes the statement that "chemicals that will not partition to water in the water/oil phase are not considered to be an item of interest in the production-to-injection cycle". This assertion suggests that a known list of chemicals that are added to the injection fluids are not disclosed. While the partitioning of many substances may favor the oil phase, ALL substances will partition into water to some degree. (Attachment A; TOXNET) This presents an unknown and unacceptable risk of contamination of the subject aquifers.

X. Conclusion

In conclusion, this report provides ample evidence to demonstrate that injected fluids may not remain in the exempted aquifers and that such injections may affect the quality of water that is, or may reasonably be, used for beneficial use. For these reasons, the Application for the expansion of the exemption in the Cat Canyon Oil Field has not demonstrated compliance with Public Resources Code Section 3131(a)(2)-(3).

Sincerely,



Barry Keller, PhD
CA Professional Geologist #4460
CA Certified Hydrogeologist #370

Dr. Jay C. Means, Ph. D., DABT[07-12], ATS
Professor of Toxicology and
Environmental Chemistry [retired]

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Attachment A

What is a Material Safety Data Sheet (MSDS)?

A material safety data sheet is a technical document which provides detailed and comprehensive information on a controlled product related to:

- health effects of exposure to the product
- hazard evaluation related to the product's handling, storage or use
- measure to protect workers at risk of exposure
- emergency procedures.

The data sheet may be written, printed or otherwise expressed, and must meet the availability, design and content requirements of WHMIS legislation. The legislation provides for flexibility of design and wording but requires that a minimum number of categories of information be completed and that all hazardous ingredients meeting certain criteria be listed subject to exemptions granted under the Hazardous Materials Information Review Act.

The Purpose of the Data Sheet

The data sheet is the second element of the WHMIS information delivery system and is intended to supplement the alert information provided on labels. The third element of the system is the education of employees in hazard information on controlled products, including instruction in the content and significance of information on the MSDS.

Responsibilities Related to the MSDS

Suppliers

1. Develop or obtain a MSDS for each controlled product imported or sold for use in a workplace
2. Ensure the MSDS for the controlled product:
    - Discloses information that is current at the time of sale or importation of the product
    - Was prepared and dated not more than three years before the date of sale or importation
    - Is available in both official languages
3. Ensure the purchaser of the controlled product has a copy of the current MSDS at the time of or prior to the purchaser receiving the controlled product
4. Make available any information that is considered confidential (trade secret) information and therefore exempt from disclosure to any physician or nurse who requests that information for the purpose or making a medical diagnosis or providing medical treatment

Employer

1. Ensures that an up-to-date supplier MSDS is obtained from the supplier the first time a controlled product is received in the workplace
2. Evaluates the data sheet received to determine its date of production. The data sheet must be dated within 3 years of current date
3. Maintains up-to-date MSDSs:

- As soon as practical but no later than 90 days after new hazard information becomes available to the employer
- At least every ***three*** years

4. Ensures a copy of all data sheets which are required for the workplace are made ***readily available*** at the worksite to:
   - Workers who may be exposed to the controlled product
   - The occupational health committee (OHC)

   Note: The MSDSs may be made available on a computer if the employer takes all reasonable steps to keep the terminal in working order, makes the data sheets readily available to the employee and provides training in accessing the computer stored data to the employee.
5. Ensure that the employee who works with a controlled product or in proximity to a controlled product is instructed in:
   - The content required on the MSDS
   - The purpose and significance of information contained in it

   Instruction must ensure that employees know procedures for the safe use, storage, handling and disposal of controlled products including procedures in the event of an emergency involving a controlled product.
6. Provide confidential (trade secret) information to a doctor or nurse who request this information for purposes of making a medical diagnosis or rendering medical treatment in an emergency
7. The employer can produce data sheets in order to provide additional information or alter the format used as long as there is no less information provided than the original supplier MSDS contained

Worker

Following training by the employer:

1. Follows the safe work or preventative measures as instructed by the employer
2. Knows where the sheets are located and how to find pertinent information on safe use and first aid measures

Material Safety Data Sheet Content

A supplier material safety data sheet must provide at least nine categories or sections of content and approximately sixty items of information distributed among those categories. An MSDS must be reviewed at least every three years. The categories must have the following similar headings:

I. Hazardous Ingredients

This section will include:

- The chemical names and concentrations concerning the hazardous ingredients
- The *LD 50* and *LC50* indicate the short term toxic potential
- *CAS number* which is useful in locating more information especially if the product is known by numerous names\

II. Preparation Information

This section includes:

- The name address and telephone number of who prepared the MSDS

- The date the MSDS was prepared
  - If more than **three** years old, it must be updated

III. Product Information

This section:

- Identifies the product by the name on the supplier label
- Provides the chemical name, family and formula (including molecular weight)
- Lists the product identifiers, manufacturer and supplier names, addresses and emergency telephone numbers

IV. Physical Data

This section includes information indicating how it looks and how it will behave when it is used, stored, spilled and how it will react with other products indicated through:

- The state it is in e.g. liquid
- The odour and appearance of the product
- The specific gravity, vapour density, evaporation rate, boiling point and the freezing point
- The vapour pressure, the higher the concentration the higher the possible air concentration
- The odour threshold, which is the lowest airborne concentration of a chemical that can be perceived by smell
- The pH reflecting the corrosive or irritant nature of the product

V. Fire and Explosion Hazard

This section describes:

- The temperature and conditions that can cause the chemical to catch fire or explode
  - UEL (upper explosion limit) or UFL (upper flammable limit) will indicate the highest concentration of a substance in the air that will produce a fire or explosion when a source of ignition (heat, spark or flame) is present
  - LEL (lower explosion limit) or LFL (lower flammable limit) will indicate the lowest concentration of a substance in the air that will produce a fire or explosion when a source or ignition is present
  - From the LEL to the UEL, the mixture is explosive. Below the UEL the mixture is too lean to burn; above the LEL the mixture is too rich to burn. However, concentrations above the UEL are still very dangerous because if the concentration is lowered (by introducing fresh air), it will enter the explosive range
- Means of extinction including the type of fire extinguisher required
- Personal Protective Equipment required for fire fighting
- Some of the storage requirements however more of this information is found in the reactivity data section

VI. Reactivity Data:

This section describes:

- The chemical stability of the product and its reactions to light, heat, moisture, shock and incompatible materials
- Storage requirements based on the reactivity or instability of the product
- Incompatible products that must not be mixed or stored near each other
- The need for disposal before they become extremely reactive

VII. Toxicology Properties:

This section describes:

- The harmful effects of exposure
- How the product is likely to enter the body and what effects it has on the organs in the body
- The short-term (acute) and long-term (chronic) health effects from exposure to the product
- The exposure limits, which indicates the maximum concentration in air of a hazardous substance (gas, vapour, dust, mist, fume) to which nearly all workers (without personal protective equipment) can be repeatedly exposed without adverse health effects. Exposure limits are expressed in three ways:
  - TWA (time weighted average) indicating the maximum average concentration to which workers can safety be exposed for a normal 8-hour workday or 48-hour workweek
  - STEL (short-term exposure limit) indicating the maximum concentration to which workers can safely be exposed for a period of up to 15 minutes. The STEL is higher than the TWA. It may not be sustained more than four times a day
  - C (ceiling) describes the concentration that may not be safely exceeded at any time, even for an instant. The C is higher that the STEL
- If these limits are to be exceeded, the worker must use recommended personal protective equipment. Exposure limits are expressed as ppm for gases and vapours and as mg/m^3 for dusts, fumes and mists
- Note these limits may be expressed as *OEL, PEL* and *TLV*
- Information used to assess the health problems of any employee who uses the chemical and determine if that worker's problems are related to the chemical

VIII. Preventative Measures:

This section provides:

- Instruction for the safe use, handling and storage of the product
- The personal protective equipment or safety devices required
- The steps for cleaning up spills
- Information on the waste disposal requirements

IX. First Aid Measures:

This section describes:

- Specific first aid measures related to acute effects of exposure to the product
- First aid steps in the correct sequence
- Information to assist in planning for emergencies

The MSDS may contain additional sections providing further information related to the specific product.

Location of the MSDSs

- Hard copy readily available
- Computer terminals
- Employees and others must know where the MSDS is and how to use them

MSDS revisions are required **every 3 years** or sooner if new product information is available.

Trade Secret Exemptions

Information may be withheld to protect industries' right to protect confidential business information. This information is referred to as trade secrets.

The producer of the product can withhold:

- The name and concentration of any ingredient
- Name of relevant toxicological studies

Once a claim if filed to withhold information the product label must state:

- Date the exemption filed
- Claim registration number

The MSDS must state:

- That an exemption has been granted
- Date it is granted
- Registry number
- Product hazards

Medical Access

Doctors and nurses can access withheld information however this information remains confidential.